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TRANSMISSION OF DIGITIZED VOICE, VOICEBAND DATA AND PHONE SIGNALING
OVER A PRIORITY-BASED LOCAL AREA NETWORK
WITHOUT THE USE OF VOICE OVER IP TECHNIQUES AND/OR
A SEPARATE VOICE-DEDICATED NETWORK

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TRANSMISSION OF DIGITIZED VOICE, VOICEBAND DATA, AND PHONE
SIGNALING OVER A PRIORITY-BASED LOCAL AREA NETWORK
WITHOUT THE USE OF VOICE OVER IP TECHNIQUES OR A SEPARATE
VOICE-DEDICATED NETWORK FIELD OF THE INVENTION

5 The present invention relates to the field of networking, and in particular, the transmission of digitized voice, voiceband data and phone signaling over a priority-based local area network.

BACKGROUND OF THE INVENTION

10 Home Networking

Use of local area networks ("LAN"s) in homes ("home networking") is beginning to proliferate. There are a variety of home networking mechanisms that have been or are being developed that may use various transmission media such as power lines, wireless media, and standard phone lines inside residences or other
15 dwellings, herein referred to as inside wiring. Phone line based home networking, which uses the phone line inside wiring, has been the most popular scheme so far. One set of LAN protocols that has been developed for phone line based networks is referred to as HomePNA. HomePNA is an acronym based on the name Home
Phoneline Networking Alliance, the name for the industry group that generated the
20 specifications for home networking using phone line inside wiring. This organization also uses the acronym HPNA. Specifications that have been approved include a specification for a 10 Mb/s packet based network protocol, as specified in "Interface

reference and referred to as “I.366.2”; ITU-T Recommendation I.363.2, “B-ISDN ATM Adaptation layer specification: Type 2 AAL”, September 1997, herein incorporated by reference and referred to as “I.363.2”).)

Residential Gateways

5 The possibility of transmitting different media, such as data and voice to the WAN via a DSL line is driving the emergence of a class of devices, commonly being referred to in the industry as a “residential gateway”. The name conveys the idea that this device provides a demarcation, a gateway between the residence and the WAN. Early embodiments of these residential gateways included an interface to an LAN,
10 and later a HomePNA home network, for providing connection to a computer associated with the non-real-time data applications, and locally attached phones, associated with the real-time voice applications. More recently there has been a desire to remove the restriction that the phone be directly attached to the residential gateway, since most people have a number of phones distributed in various locations
15 of their residence. Three approaches have been taken to support remote telephones as part of a residential gateway:

- 1) use a phone line adapter that converts the conventional phone analog signals into digital signals, which are then transported over a LAN or HomePNA using “voice over IP techniques”.

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SUMMARY OF THE INVENTION

A method and apparatus for transmitting digitized voice, voiceband and phone signaling over a priority-based home networking is described. According to an aspect of the present invention, analog phone signals are converted into digitized voice, voiceband data and phone signaling. The digital samples are transported as AAL2 packets via an LAN that supports levels of transmission priority. The LAN protocol may be, for example, *HomePNA 2.0*.

The use of AAL2 packets and protocols for voice applications allows a simpler design with less overhead than what can be obtained with voice over IP techniques, thus resulting in a cheaper system cost. The reuse of the HomePNA for the voice traffic avoids the need for a second logically separate home network, as has been the case in some designs, which also reduces the total system cost.

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Fig. 1 is a block diagram depicting a network architecture which may be used to implement an embodiment of the present invention;

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5 description, for the purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be apparent, however, to one skilled in the art that the present invention may be practiced without these specific details. In other instances, well-known structures and devices are shown in block diagram form in order to avoid unnecessarily obscuring the present invention.

A priority-based local area network provides the mechanism to give preference to the transport of voice over data, therefore providing a quality of the voice very close to the approach of using a logically separate network, without the inherent costs of that additional logically separate network. The same “Loop Emulation Service” techniques and methods being used from the residential gateway to the WAN portion, can be extended back to the LAN between the remote telephones and the residential gateway, therefore minimizing overhead in the interworking of different methods and protocols at the residential gateway.

EXEMPLARY NETWORK

Fig. 1 is a block diagram depicting an exemplary network 100 which incorporates an embodiment of the present invention. Exemplary network architecture includes priority based LAN 110, which is coupled to a WAN 130, for example the Internet, by means of a Residential Gateway 112, through link 114. Link 114 may be, for example, DSL transporting ATM payloads.

Priority based LAN 110 is a general purpose network that uses a transmission medium in the form of phone line inside wiring. A general purpose network is one that allows for transmission of various types of data, including non-real time data and real-time data. Priority based LAN 110 also follows an LAN protocol that supports levels of transmission priority, such as *HomePNA 2.0*. A LAN protocol that supports levels of transmission priority is a LAN protocol that defines a mechanism that causes an LAN to transmit packets according to a priority. The use of HomePNA is but one example of a priority-based LAN that may be used to implement the present invention. The present invention may be used with any LAN that provides a priority mechanism. Therefore, it is understood that the present invention is not in any way limited to HomePNA. For example, the present invention may be implemented using a powerline-based LAN, as long as the LAN defined on top of the powerline inside wiring supports levels of transmission priority.

Also coupled to LAN 110 is phone line adaptors 122 and 124, which are themselves coupled to analog telephones 126 and 128, respectively. Telephones 126

LAN 110. Non-real time client may be a general purpose computer coupled to LAN 110 via a network interface card.

TRANSMITTING DIGITIZED VOICE, VOICEBAND DATA, AND PHONE SIGNALING

5 Phone line adaptors 122 and 124 may receive and transmit digitized voice, digitized voiceband data and digitized phone signaling over LAN 110 using HomePNA. For example, phone line adaptor 124 receives analog phone signals from analog telephone 128. Phone line adaptor 124 converts the analog signal into digitized voice, voiceband data, which it encapsulates into packets that are
10 transmitted to residential gateway 112 using a high level of transmission priority, preferably the highest supported by the HomePNA protocol. The level of transmission priority may be controlled by, for example, setting a field in the HomePNA frame header. Further details about how data may be transmitted using levels of transmission priority may be found in the *HomePNA 2.0*.

15 PHONE LINE ADAPTOR

Fig. 2 is a block diagram depicting a phone line adaptor 122 in greater detail. Referring to Fig. 2, phone line adapter 122 is coupled to analog phone 126 via a small length piece of phone line. Phone line adapter 122 includes a Coder/Decoder (“Codec”) block 230, Subscriber Line Interface Circuit (SLIC) block 235, “glue”
20 logic block 240, and an Network interface block 250. A Codec block, such as Codec block 230, is a mechanism that converts analog phone signals into binary output,

such as digital voice sample data. A Codec block also converts digital voice sample data into analog phone signals. A SLIC block, such as SLIC block 235, is a mechanism that converts analog phone signaling into their corresponding digital indication, and vice-versa.

5 Network Interface block 250 is a standard component that implements the networking functionality for exchanging data packets and frames over an LAN. An example of such standard components for an HomePNA network is a device such as the BCM4210 by Broadcom Corporation.

10 “Glue” logic block 240 is a block that encapsulates the digital voice and voiceband data output by the Codec block 230 and digitized phone signaling output by SLIC block 235, into the appropriate packet format for transmission over the LAN through the Network Interface block 250. The “glue” logic block 240 also receives packets from the LAN through the Network Interface block 250 and recovers: a) the contained digital voice and voiceband data which it feeds to the
15 Codec block 230 and b) the digitized phone signaling, which it feeds to the SLIC block 235 for further conversion into analog phonesignaling.

PACKET FORMATS

20 Phone packets transmitted via an LAN must conform to the protocol used by the network. Accordingly, phone packets transmitted over LAN 110 follow a general format that conforms to the HomePNA specification, from the physical and link

CID		2
LI value 43 (number of bytes-1:from byte 4 to 48)	UUI	3
UUI (cont)	HEC (CRC-5)	4
Payload		5 to 48

Each phone adapter must be allocated a unique (in the context of a LAN) identification, which is used in the CID field to identify the source / destination of the packet. For common telephones (referred in the industry as POTS phones) the values of CID should be allocated from the range 16-127, as indicated in Table 1 in section 4.4.2 of ATM Forum document FB-VMOA-0145.000. The choice of an adapter identifier (CID) can be done by use of small thumbswitches in the phone adapter, for example. The LI (length indicator), and HEC (Header Error Control) fields are populated as explained in section 9.1 of I.363.2. The UUI (User-to-User Indication) field is also explained in section 9.1 of I.363.2, and more specifically as detailed in the explanation and references provided in the next paragraphs.

VOICE AND VOICEBAND DATA PACKETIZATION

Digitized voice and voiceband data samples are carried in the payload field of the above AAL2 packet, in what is referred to as "type 1" packets in section 10.1

of I.366.2, and which are identified by the use of the UUI field values of 0-15, as indicated in Table 12-1 of I.366.2.

Various formats and encodings (referred to as profiles) can be used, as summarized in Annex P of I.366.2, and detailed in Annexes A through I of I.366.2.

- 5 Details of the procedures associated with the profiles are found in sections 13 and 14 of I.366.2.

- 10 The following chart, which shows the voice and voiceband data packet format is based on the use of ATM Forum predefined profile 9. This particular profile uses 44 bytes of G.711-64 voice / voiceband data samples, without silence suppression, as shown in Table A-1 of ATM Forum document FB-VMOA-0145.000.

8	7	6	5	4	3	2	1	
OSF value 47 decimal						SN	P	1
CID								2
LI value 43 (number of bytes-1:from byte 4 to 48)						UUI		3
UUI (cont)			HEC (CRC-5)					4
G.711-64 sample 1								5
G.711-64 sample 2								6
G.711-64 sample 43								47
G.711-64 sample 44								48

The following chart, which shows the voice and voiceband data packet format is based on the use of ITU-T predefined profile 1. This particular profile uses

implemented. The encoding of so called ABCD signaling bits in the “channel associated signaling” messages is made according to the GR-303 states shown in Tables B-1 and B-2 of the ATM Forum document FB-VMOA-0145.000. For the most common type of phones used in residences, the coding corresponding to “Loop Start” signaling type shall be used.

The chart below shows the “Channel associated signaling” message.

8	7	6	5	4	3	2	1	
OSF value 47 decimal						SN	P	1
CID								2
LI value 4 (number of bytes-1:from byte 5 to 10 inclusive)						UUI		3
UUI (cont)			HEC (CRC-5)					4
Redundancy		Timestamp						5
								6
RESERVED				A	B	C	D	7
000011 “Channel Associated Signaling” message						CRC-10		8
CRC-10 (cont.)								9
Pad (0)								10
Pad (0)								11
o Pad (0) o o								12
Pad (0)								47
Pad (0)								48

The implementation of message type “Dialed Digits” and “Facsimile demodulation control” which are listed in Table 10.1 of I.366.2 are optional, and necessary only when an encoding profile that does not support transparent transport

of DTMF tones is used (typically profiles that use compression below 32 kb/s, since at that level of compression tones used for dialing and in fax machines may not be recognized if simply encoded as "voice" samples). If the "Dialled Digits" message is implemented, the details and corresponding procedures are covered in Annex K of I.366.2. In particular, for phone applications, the digits type of "DTMF" shall be selected. If the "Facsimile demodulation control" message is implemented, the details and corresponding procedures are covered in Annex M of I.366.2.

ALTERNATE EMBODIMENTS

The present invention has been illustrated using phone line adapters that interface to analog telephones. However, the present invention is not limited to use of analog telephones. For example, other devices that interface with analog phone input may be connected to the phone line adapters. For example, fax machines, phone answering machines, and caller id boxes may be connected to a phone line adapter.

Furthermore, the present invention is not limited to phone line adapters that are separate units connected to the analog phone devices. The present invention encompasses any device that is designed to generate packets and interface with a phone line based LAN that supports levels of transmission priority. For example, a phone unit may itself be designed to generate and receive such packets over a phone line based LAN that supports levels of transmission priority. The phone unit may contain components similar to those contained in the phone line adapter, or may be designed in some other way to generate and receive packets containing digital phone

data over a phone line based LAN that supports levels of transmission priority. Therefore, it should be understood that the present invention is not limited to phone line adaptors that are external to phone analog device connected to them.

Furthermore, although the description of this invention makes reference, by
5 example, to phoneline priority-based home networks, this is not intended to constrain the present invention to only those networks. In fact the same invention can be used, for example, with powerline priority-based home networks, if such home networks are defined.

Finally, the reference to a home network or residential gateway should also
10 not be construed to limit the present invention scheme to uses in a home or residences. The present invention may be implemented in any structure, be it a residence, an office, or other dwelling, that contains wiring on top of which a priority-based networking scheme may be used.

15 NETWORK AND COMPUTER HARDWARE DESCRIPTION AND TERMINOLOGY

A computer network typically comprises a plurality of interconnected
entities that transmit or receive data frames. A common type of computer network is
an LAN that generally comprises a privately owned network within a single building
20 or campus. LANs employ a data communication protocol (LAN standard) such as Ethernet, that defines the functions performed at the physical layers of a communications architecture (i.e., a protocol stack), such as the Open Systems Interconnection (OSI) Reference Model. In many instances, multiple LANs may be

interconnected by point-to-point links, microwave transceivers, satellite hookups, etc., to form a WAN, metropolitan area network ("MAN") or Intranet. These internetworks may be coupled through one or more gateways to the global, packet-switched internetwork known as the Internet.

- 5 Each network entity preferably includes network communication software, which may operate in accordance with Transport Control Protocol/Internet Protocol (TCP/IP) or some other suitable protocol. A protocol generally consists of a set of rules defining how entities interact with each other. In particular, TCP/IP defines a series of communication layers, including a transport layer and a network layer. At
- 10 the transport layer, TCP/IP includes both the User Data Protocol (UDP), which is a connectionless transport protocol, and TCP which is a reliable, connection-oriented transport protocol. When a process at one network entity (source) wishes to communicate with another entity, it formulates one or more messages and passes them to the upper layer of the TCP/IP communication stack. These messages are
- 15 passed down through each layer of the stack where they are encapsulated into packets and frames. Each layer also adds information in the form of a header to the messages. The frames are then transmitted over the network links as bits. At the destination entity, the bits are re-assembled and passed up the layers of the destination entity's communication stack. At each layer, the corresponding message
- 20 headers are also stripped off, thereby recovering the original message which is handed to the receiving process.

specific, fixed TCP and/or UDP port numbers in accordance with Request For Comments (RFC) 1700. For example, TCP/UDP port number 80 corresponds to the Hypertext Transport Protocol (HTTP), while port number 21 corresponds to File Transfer Protocol (FTP) service.

5 Figure 3 is a block diagram that illustrates a computer system 300 upon which an embodiment of the invention may be implemented. Computer system 300 includes a bus 302 or other communication mechanism for communicating information, and a processor 304 coupled with bus 302 for processing information. Computer system 300 also includes a main memory 306, such as a random access memory (RAM) or
10 other dynamic storage device, coupled to bus 302 for storing information and instructions to be executed by processor 304. Main memory 306 also may be used for storing temporary variables or other intermediate information during execution of instructions to be executed by processor 304. Computer system 300 further includes a read only memory (ROM) 308 or other static storage device coupled to bus 302 for
15 storing static information and instructions for processor 304. A storage device 310, such as a magnetic disk or optical disk, is provided and coupled to bus 302 for storing information and instructions.

Computer system 300 may be coupled via bus 302 to a display 312, such as a cathode ray tube (CRT), for displaying information to a computer user. An input
20 device 314, including alphanumeric and other keys, is coupled to bus 302 for communicating information and command selections to processor 304. Another type of user input device is cursor control 316, such as a mouse, a trackball, or cursor direction keys for communicating direction information and command selections to

coupling to a network link 320 that is connected to a local network 322. For example, communication interface 318 may be an integrated services digital network (ISDN) card or a modem to provide a data communication connection to a corresponding type of telephone line. As another example, communication interface

5 318 may be a local area network (LAN) card to provide a data communication connection to a compatible LAN. Wireless links may also be implemented. In any such implementation, communication interface 318 sends and receives electrical, electromagnetic or optical signals that carry digital data streams representing various types of information.

10 Network link 320 typically provides data communication through one or more networks to other data devices. For example, network link 320 may provide a connection through local network 322 to a host computer 324 or to data equipment operated by an Internet Service Provider (ISP) 326. ISP 326 in turn provides data communication services through the world wide packet data communication network

15 now commonly referred to as the "Internet" 328. Local network 322 and Internet 328 both use electrical, electromagnetic or optical signals that carry digital data streams. The signals through the various networks and the signals on network link 320 and through communication interface 318, which carry the digital data to and from computer system 300, are exemplary forms of carrier waves transporting the

20 information.

Computer system 300 can send messages and receive data, including program code, through the network(s), network link 320 and communication interface 318. In the Internet example, a server 330 might transmit a requested code

